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*Original Article*

# Preoperative T1 magnetic resonance imaging changes carry a poor postoperative prognosis in cervical myelopathy: A retrospective study of 182 patients

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## ABSTRACT

**Background:** T2 scans are widely used to determine the prognosis for patients undergoing surgery for cervical myelopathy. In this study, we determined whether T1 MR changes in addition to T2 MR changes could have prognostic importance.

**Methods:** This retrospective analysis involved 182 patients undergoing surgery for cervical myelopathy (2017–2020). There were 110 patients in Group 1 (only T2 MR changes) and 72 in Group 2 (both T1 and T2 MR changes). In addition, demographic, visual analog score (VAS), modified Japanese Orthopaedic Association (mJOA) scores, and operative details were recorded at 1 month, 3 months, 6 months, and 1 year postoperatively.

**Results:** Notably, VAS scores were comparable at each point in time and were significantly better than the preoperative scores at 1 year postoperatively. Although mJOA scores were comparable at 1 month in both groups, they were better thereafter for Group 1 patients.

**Conclusion:** The presence of T1 changes on the preoperative magnetic resonance imaging represented a poor prognostic indicator for the postoperative outcome compared to the presence of T2 changes alone.

**Keywords:** Cervical myelopathy, Magnetic resonance imaging changes, Modified Japanese Orthopaedic Association, Prognostic, Visual analog score

## INTRODUCTION

The prognostic impact of T1 MR findings in patients with myelopathy undergoing surgery needs to be further studied.[1-3,7,8] Notably, the majority of prior studies have focused on the prognostic importance of preoperative T2-weighted MR studies alone, with very little weight being given to T1 findings. Here, we have focused on the value of T1 MR changes to better predict whether patients undergoing surgery for cervical myelopathy will have poorer outcomes.

## MATERIALS AND METHODS

This retrospective analysis involved 182 patients undergoing cervical surgery for myelopathy (2017–2020) [Table 1]. Patients were then placed in two groups based on the presence of signal

changes on the preoperative magnetic resonance imaging (MRI). Of these, 110 belonged to Group 1 (only T2 changes) and 72 belonged to Group 2 (both T1 and T2 changes). We could not find any patient who had only T1 change on their MRI in the absence of T2 changes.

The criteria used in the study and the respective times of assessment are shown in [Table 2]. All patients had preoperative MR scans, and the presence of the signal changes was assessed by the radiologist who was blinded to the study design.

### Statistical analysis

The statistical analysis was performed using SPSS version 23.0. Paired Student's t-test was used for statistical testing of difference in mean values for comparing between preoperative and postoperative outcomes. P = 0.05 was considered to be statistically significant. Pearson's correlation was used to analyze the association between two variables. The analysis of variance test was used to analyze multiple variables. Values were reported as mean ± standard deviation of the mean.

## RESULTS

The demographic, baseline characteristics, baseline functional scores, and operative were comparable for the two groups [Table 3]. A majority of the patients were operated by the anterior approach and most had a single-level procedure [Table 4]. Modified Japanese Orthopaedic Association (mJOA) scores were comparable preoperatively for both groups, and both significantly improved at postoperative 1 year. Nevertheless, the scores at each point of assessment were significantly better in Group 1 (only T2 changes) [Table 5].

Visual analog score (VAS) was also comparable preoperatively. However, in contrast to the mJOA scores, the VAS was comparable among the two groups at each point of assessment postoperatively [Table 6].

**Table 1:** Inclusion and exclusion criteria.

| Inclusion criteria | Exclusion criteria |
|---|---|
| Age>45 years | No MRI changes |
| Follow-up at least 1 year | Preexisting spondyloarthropathies |
| Consent for participation | History of trauma |
| | History of the previous cervical spine surgery |

## DISCUSSION

MRI and the wide and huge data that it provides have led to various prognostic factors being increasingly studied.[1,3,4,7] The outcomes following the presence of T2 changes have been discussed widely [Table 7].

### Grading T2 changes

Grading of T2 changes on the MRI ranged from no change to mild with fuzzy borders, intense, and well-defined border of the hyperintensity in the cord,[4] notably, some found intense hyperintensity was associated with a poor outcome, while others saw no correlation.[4,9]

### T1 cord changes on MRI

T1 changes have also been studied and have been shown to be independent predictors of functional outcomes. T1 changes most likely represent irreversible changes that occur in the cord and thus provide a better indication regarding prognosis

**Table 2:** Various criteria used for assessment in the study.

| Clinical and demographic | | Perioperative | | Functional | |
|---|---|---|---|---|---|
| **Variable** | **Assessed at** | **Variable** | **Assessed at** | **Variable** | **Assessed at** |
| Age | Preoperative assessment | Duration of surgery | Immediate postsurgery | Visual analog score | Preoperative, 3 months postoperative, 6 months postoperative, and 1 year postoperative |
| Sex | | Blood loss | | Modified Japanese Orthopaedic Association score | |
| BMI | | Approach | | | |
| Duration of symptoms | | Number of levels operated on | | | |
| Comorbidities | | Hospital stays | Discharge from the hospital | | |
| Follow-up | Last follow-up visit | | | | |

**Table 3:** Demographic variables of the study population.

| Variable | Group 1 (only T2) *n*=110 | Group 2 (both T1 and T2) *n*=72 | *P*-value |
|---|---|---|---|
| Age (years) | | | |
| Mean | 55.4 | 57.5 | 0.16 |
| Standard deviation | 10.2 | 9.5 | |
| Gender | | | |
| Male | 65 | 38 | 0.40 |
| Female | 45 | 34 | |
| BMI | | | |
| Mean | 27.5 | 28.4 | 0.20 |
| Standard deviation | 5.1 | 3.8 | |
| Duration of symptoms (months) | | | |
| Mean | 5.2 | 5.8 | 0.28 |
| Standard deviation | 3.5 | 3.8 | |
| Symptoms | | | |
| Neck pain | 89 | 60 | 0.83 |
| Radiculopathy | 31 | 19 | 0.92 |
| Gait imbalance | 42 | 34 | 0.29 |
| Bowel/bladder involvement | 15 | 9 | 0.99 |
| Follow-up (months) | | | |
| Mean | 16.4 | 17.0 | 0.20 |
| Standard deviation | 3.4 | 2.5 | |
| Comorbidities | | | |
| Smoking | 17 | 8 | 0.54 |
| Hypertension | 24 | 15 | 0.98 |
| Diabetes mellitus | 29 | 20 | 0.97 |
| Cardiac disease | 20 | 11 | 0.76 |
| COPD | 4 | 3 | 0.83 |
| Thyroid disorder | 12 | 11 | 0.52 |
| Dyslipidemia | 18 | 10 | 0.81 |

BMI: Body mass index; COPD: Chronic obstructive respiratory disease

**Table 4:** Perioperative variables of the patients in the two groups.

| Variable | Group 1 (only T2) *n*=110 | | Group 2 (both T1 and T2) *n*=72 | | *P*-value |
|---|---|---|---|---|---|
| | Mean | Standard deviation | Mean | Standard deviation | |
| Duration of surgery (minutes) | 125.8 | 20.1 | 131.5 | 32.1 | 0.14 |
| Blood loss (milliliters) | 145.7 | 35.8 | 151.4 | 38.9 | 0.31 |
| Hospital stays (days) | 6.4 | 2.4 | 6.9 | 2.0 | 0.14 |
| Number of levels | | | | | |
| 1 | 72 | | 43 | | 0.73 |
| 2 | 33 | | 25 | | |
| 3 | 5 | | 4 | | |
| Approach | | | | | |
| Anterior | 60 | | 46 | | 0.35 |
| Posterior | 42 | | 20 | | |
| Combined | 8 | | 6 | | |

after the surgery. T2 changes, typically due to cord edema, obstruction of the cerebrospinal fluid, degeneration of the gray matter, or myelomalacia, have a greater chance of being reversible. Thus, in the absence of T1 changes, T2 changes alone might represent an ideal window for intervention to prevent further and permanent deterioration.

**Table 5:** Comparison of modified Japanese Orthopaedic Association scores at the various time intervals among the three groups.

| Group | Preoperative | Postoperative 3 months | Postoperative 6 months | Postoperative 1 year | Significance of the improvement in ODI score at 1 year (*P*-value) |
|---|---|---|---|---|---|
| Group 1 (only T2) | | | | | |
| *n*=110 | | | | | |
| Mean | 12.1 | 15.6 | 16.2 | 16.7 | <0.0001 |
| Standard deviation | 2.5 | 2.3 | 3.1 | 3.4 | |
| Group 2 (both T1 and T2) | | | | | |
| *n*=72 | | | | | |
| Mean | 12.5 | 14.0 | 14.8 | 15.1 | <0.0001 |
| Standard deviation | 2.0 | 3.1 | 3.0 | 3.9 | |
| *P*-value | 0.26 | <0.0001 | 0.003 | 0.004 | |

*P*<0.05 is statistically significant

**Table 6:** Comparison of visual analog scores at the various time intervals among the three groups.

| Group | Preoperative | Postoperative 3 months | Postoperative 6 months | Postoperative 1 year | Significance of the improvement in ODI score at 1 year (*P*-value) |
|---|---|---|---|---|---|
| Group 1 (only T2) | | | | | |
| *n*=110 | | | | | |
| Mean | 3.9 | 2.8 | 2.1 | 1.5 | <0.0001 |
| Standard deviation | 1.0 | 1.0 | 0.8 | 1.0 | |
| Group 2 (both T1 and T2) | | | | | |
| *n*=72 | | | | | |
| Mean | 4.0 | 3.1 | 2.3 | 1.6 | <0.0001 |
| Standard deviation | 1.2 | 1.1 | 1.0 | 1.1 | |
| *P*-value | 0.54 | 0.06 | 0.14 | 0.53 | |

*P*<0.05 is statistically significant

**Table 7:** Comparison of various studies analyzing the effect of MRI findings on the prognosis.

| S. No. | Authors | Type of study | Sample Size | Type of change | Functional Outcome measures | Findings |
|---|---|---|---|---|---|---|
| 1. | Wada *et al.*[8] | Retrospective | 50 | T2 | Japanese Orthopaedic Association score | High-intensity T2 changes correlated poorly with the recovery rate |
| 2. | Vedantam and Rajshekhar[7] | Review | Multiple | T2 | Multiple | T2 changes represent a poor surgery outcomes |
| 3. | Chikhale *et al.*[5] | Retrospective with prospective data collection | 50 | T2 | Modified Japanese Orthopaedic Association score | Sharp and focal T2 hyperintensity changes had poor outcomes |
| 4. | Ahn *et al.*[1] | Retrospective | 39 | T2 | Japanese Orthopaedic Association score | High-intensity T2 changes indicate a poor prognosis |
| 5. | Avadhani *et al.*[3] | Retrospective | 35 | T1 and T2 | Nurick grading | T2 changes alone have no prognostic significance |
| 6. | Alafifi *et al.*[2] | Retrospective | 76 | T1 and T2 | Nurick grading and Odom's criteria | T2 changes with no clonus or spasticity have better outcomes. T1 changes represent a poorer outcomes |

### Are T1 and T2 changes combined better predictors of outcome?

The combined T1 and T2 MR cord changes in patients with cervical myelopathy are more predictive of poorer outcomes.[4] Suri *et al.*[6] also observed that a combination of T1 and T2 changes represents a poor prognostic indicator. In our study as well, the presence of T1 changes in addition to the T2 changes showed a significantly inferior outcome, likely due to irreversible damage.

## CONCLUSION

Both T1 and T2 MR changes constitute a poorer prognostic sign versus T2 changes alone for those about to undergo cervical spine surgery for myelopathy.

### Declaration of patient consent

Patient's consent not required as patients identity is not disclosed or compromised.

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### Conflicts of interest

There are no conflicts of interest.

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